

Consumer Acceptance of Electric Vehicles in the US

Mobile Source Technical Review Subcommittee

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Outline

- **Consumer Profiles.** If demographic profiles of EV early adopters are accurate, most surveys indicate that the initial market size is quite limited.
- **Sales Forecasts.** Wide range of expectations about consumer enthusiasm for battery electrics.
- **Market Barriers.** Consumer concerns include price differential, range, recharging infrastructure, speed of recharge.
- **Public Policy.** Sustained supporting policies including price incentives for EVs over the long-term (to 2020 and beyond) will extremely important.

Consumer Profiles

**Early Adopters, Early
Majority, Advocates,
Moderates, Resisters . .**

▪

Consumer profiles

Early adopter: similar to early adopters of hybrids - young, high income, EV as second vehicle, concentrated in Southern California with good weather and recharging infrastructure.

Early majority: 1.3 million in this segment based on demographic attributes:

- Higher-than-average income (\$114k)
- Urban or suburban residence
- Private garage with electrical power
- Low weekly mileage (100 miles)
- Environmental sensitivity
- Concern about dependence on foreign oil
- Political activity, and
- Willingness to pay for convenience.

Deloitte.

Gaining traction

A customer view of electric vehicle mass adoption in the U.S. automotive market



Purpose: Assess future demand for EVs.

Method: Interviews with executives from major auto companies, start ups, energy companies, dealers, and 2,000 current vehicle owners.

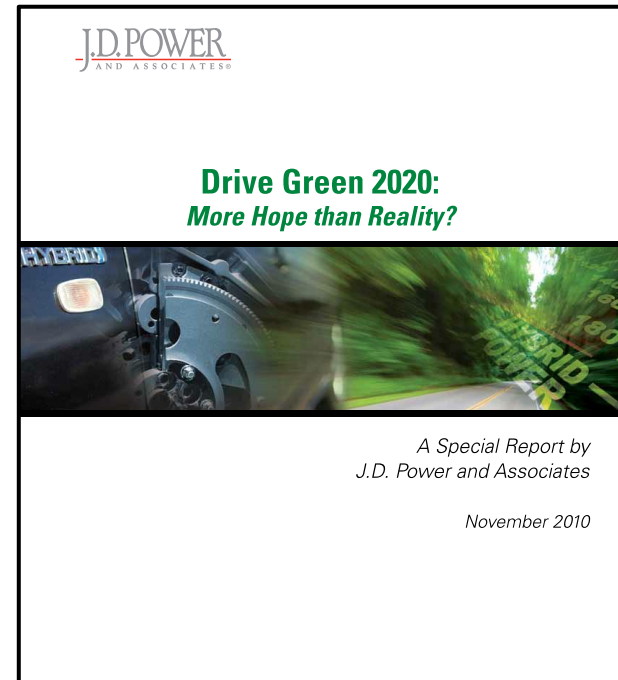
US Outlook

- EV models in the US include Chevy Volt, Nissan Leaf, Tesla Roadster, iMiEV, Ford C Max Energi, Toyota Plug-in.
- BEV sales projection: 107K in 2020, or 1% of LDV sales.

Profile of US BEV Consumer (based on HEV buyers): Most prominent characteristic is higher education: 42% postgrads v. 25%.
. Other factors – age, marital status, income – largely similar.

Purchasing behavior: HEV buyers cite gas mileage 90% compared to 40% all buyers; environmental impact 70% v. 10%; Advanced technology 70% v. 32%.

Differences with other buyers: HEV buyers care far less about interior comfort and exterior styling compared to all buyers.



Purpose: Estimate demand for HEVs and BEVs.

Relevant Finding: Just under 2% of global sales by 2020; 1% in US.

Regional Mix: EU (62%), China (21%), US (7.5%).

Corporate leader: Renault-Nissan (33% market).

Finding: Significant gap between consumer expectations and EV performance.

- **Range Gap:** Expectations outpaced reality by factor of 2 or 3. Energy density expected to increase 20 to 50% by 2020.
- **Recharge time:** less than 2 hours (Japan less than 30 minutes); only small percentage viewed 8 hour recharge as acceptable.
- **Price premium:** Majority of consumers not willing to pay a premium; EVs 50% price premium.
- **Purchase price:** Vast majority of consumers expect to pay less than \$30,000.
- **Fuel price:** With higher fuel prices, consumers more interested in EVs.
- **Fuel Efficiency:** When fleet fuel economy reaches 50 mpg, consumers less interested in EVs.

Bottom line: When consumer expectations compared to existing products, market size limited to 2 to 4% of population in countries surveyed.



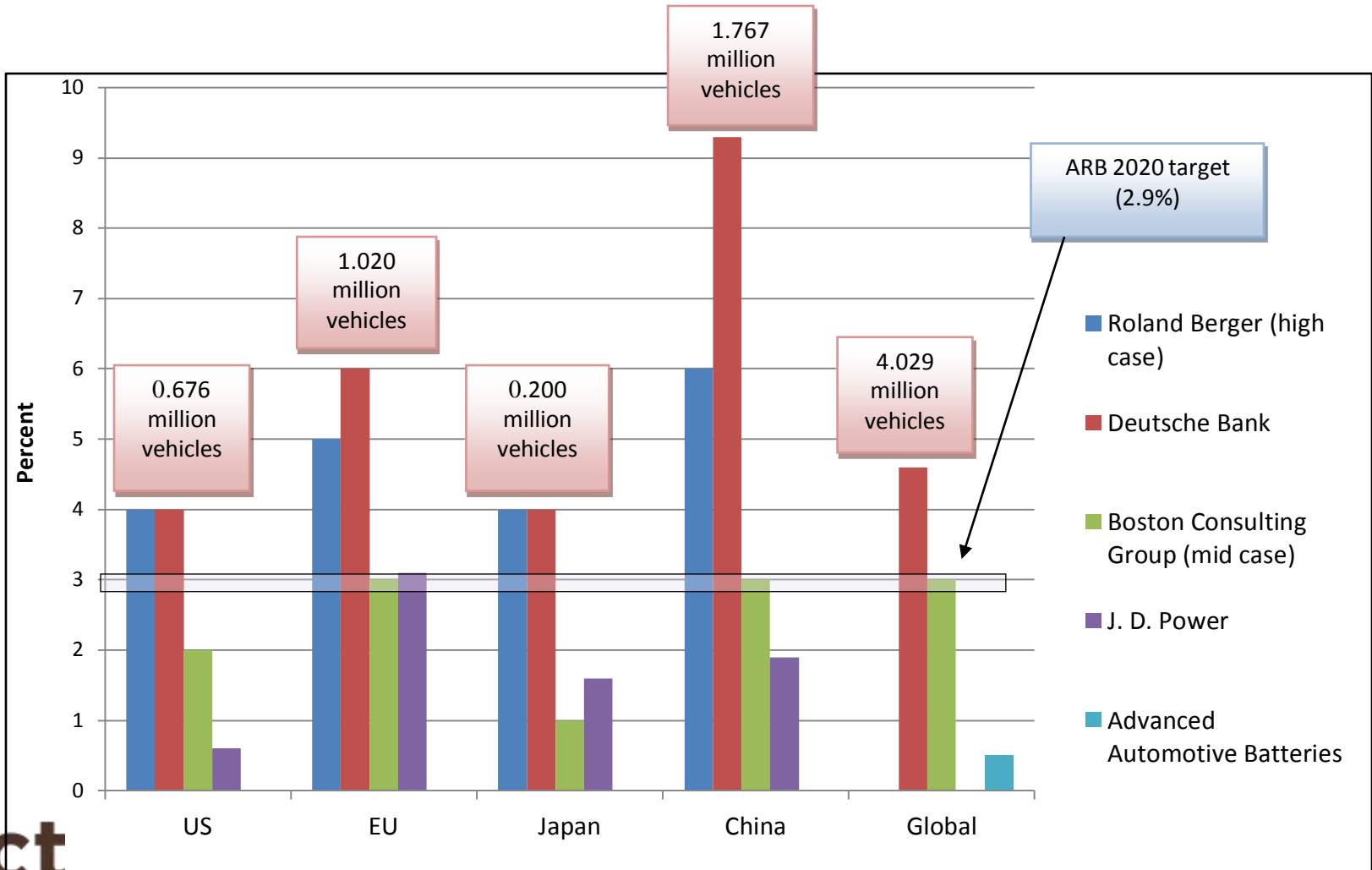
Unplugged:
Electric vehicle realities versus
consumer expectations

- Global study to understand consumer attitudes towards battery electrics.
- Surveyed 13,000 individuals in 17 countries.
- Conducted November 2010 to May 2011

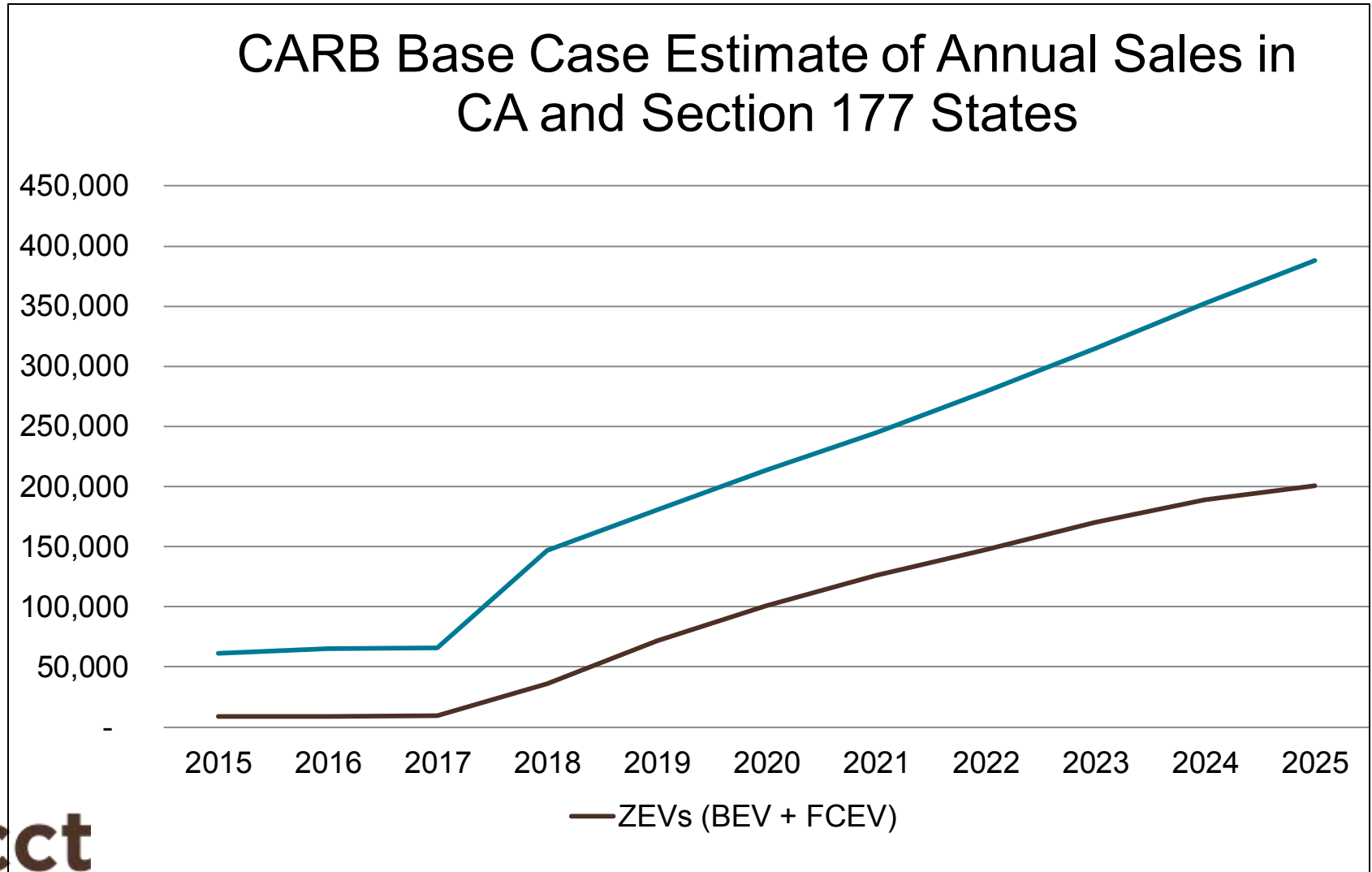
EV Sales Forecasts

CARB
JD Power
Boston Consulting
Deloitte

Projected BEV Penetration Rates, 2020



CA ZEV Program Requirements



U.S. Map Color Coded to Reflect Predicted EV Buying Preferences Largely Consistent with ZEV States

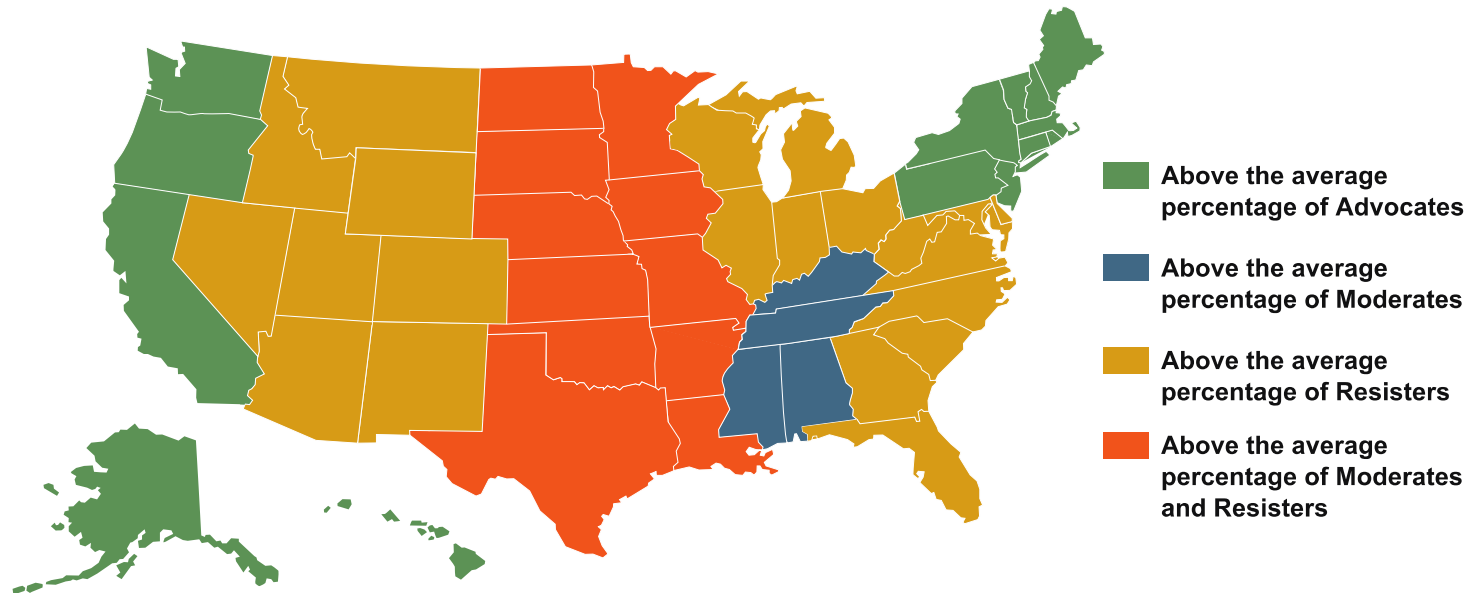
Three categories of EV buyers

Advocates – universally committed to green; 21% of study sample

Moderates – sometimes committed to green; 66% of study sample.

Resisters – consumers who do not embrace any green initiatives; 13% of study sample.

Consumer Groups by Region



Market Barriers

**Price, Range, Recharge
Time, Infrastructure,
Risk Aversion . . .**

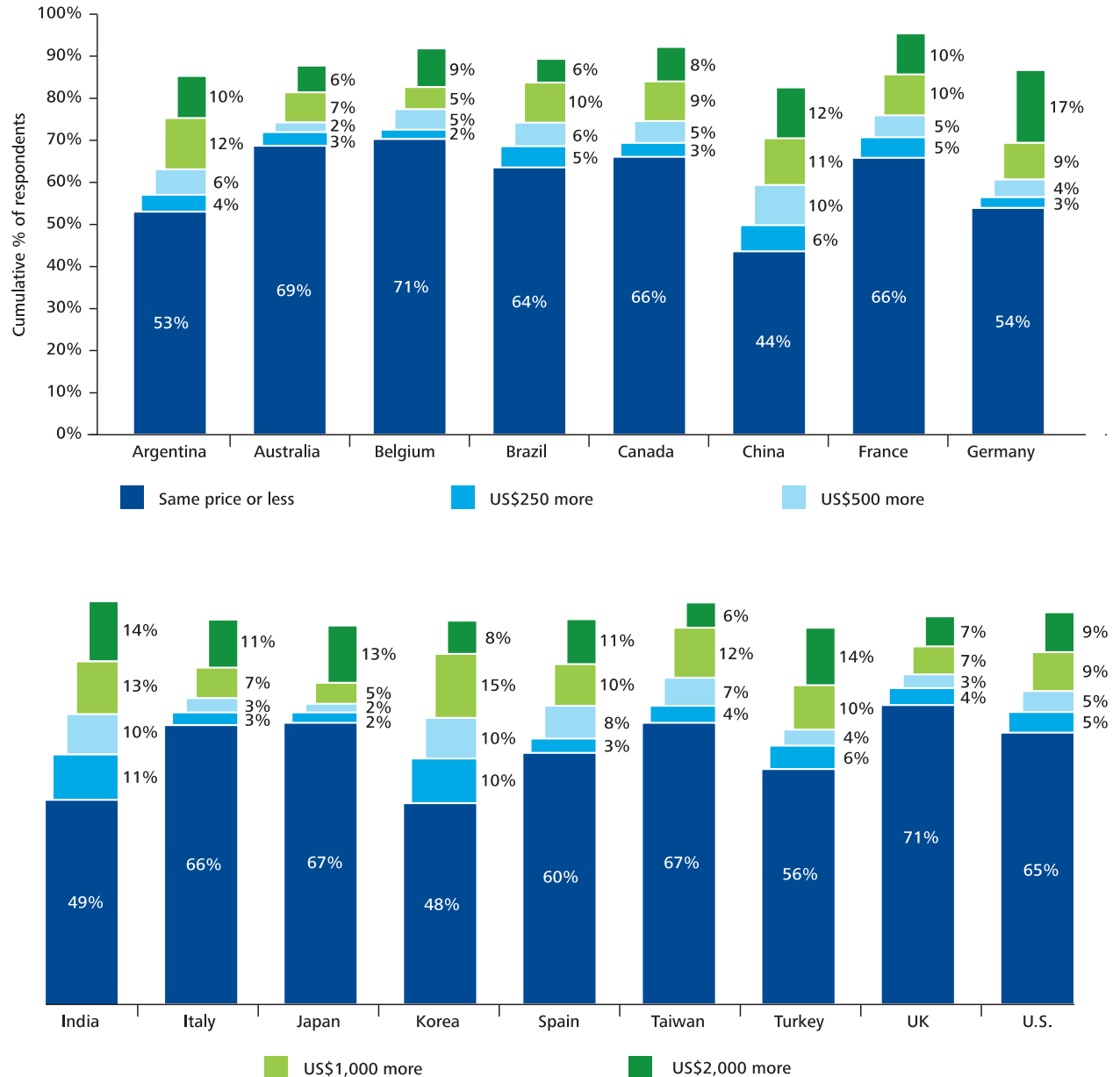
Market Barriers: Price

- Consumer survey literature consistently finds that price is a major barrier to electric vehicle sales.
- Price includes the price premium between an EV and a comparable internal combustion engine.
- Surveys have also found that consumers are reluctant to pay more than a certain amount for an electric vehicle, typically around \$30,000. This is because “first cost” matters as well as price.
- Some important factors that influence price are battery costs and price of gasoline.
- Battery costs are expected to fall to about half current levels, but one consultant speculated that a variety of factors such as increased cost of raw materials, increases in technology and need to greater range and thus larger batteries would tend to offset the falling price.
- Consumers have also indicated a greater willingness to purchase an EV when gasoline prices are high.
- One report identified a conflict between government policies to improve vehicle efficiency and thus lowering the cost to drive and electric vehicle policies.

Notice survey questions did not include a price premium above \$2,000 despite EV premiums at over \$10,000.

Figure 9: Consumers are not willing to pay a price premium

Survey question: How much more would you be willing to pay for an electric vehicle compared to a similar vehicle with a gasoline engine?



Source: Unplugged, Deloitte (2011)

Market Barriers: Recharging Infrastructure

- “If electric vehicles are to reach a broad market, rather than just serving as second cars for city dwellers with large garages, it will be essential to create a public electric charging infrastructure.” (BCG at 9).
- In one survey, 54% of surveyed consumers would not consider purchasing an EV until charging locations are widely available and as easy to locate as gas stations today.
- One case study: with 10% vehicle stock as electric, increased electric energy demand by less than 2%.
- Electric companies paying for the cost of recharging infrastructure amortized over 15 years, the cost would be double electric price.
- Under current conditions, difficult business case for utilities to invest in EV recharging infrastructure without strong government incentives and “clear technology roadmap from OEMs.”

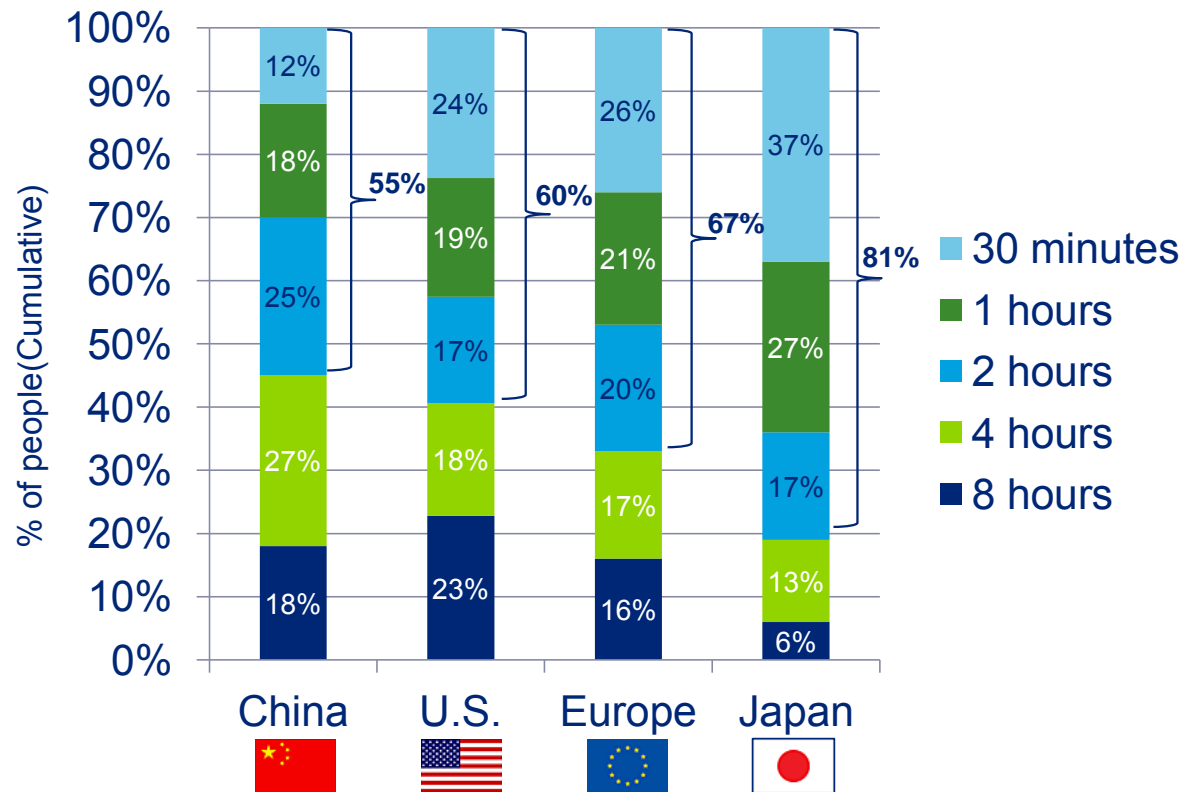
Market Barriers: Recharge Time

- So-called “fast” chargers are not fast enough
 - 30 minute recharge unacceptable to mainstream customers
 - In one survey, auto executive explained: “You need an electric car that can recharge in five minutes – that’s how a gas station works.”
- Battery chemistries and designs have trade offs between energy density, cost, weight and recharge times.
 - High energy battery designs (Li-ion) are limited to a 30 minute recharge.
 - Hybrid batteries are designed for high power and can be recharged in less than 5 minutes, but they are three times the cost and twice the size and weight per kWh.
- Batteries beyond Li-ion (e.g. Li-air) have potential to improve range to 200-400 miles, but have even longer recharge times.

Notice that recharge time of 5 minutes was not considered in this survey

Charge time for EVs of 2 hours or less is expected by the majority of individuals

Longest Acceptable Time to Fully Recharge EV Battery

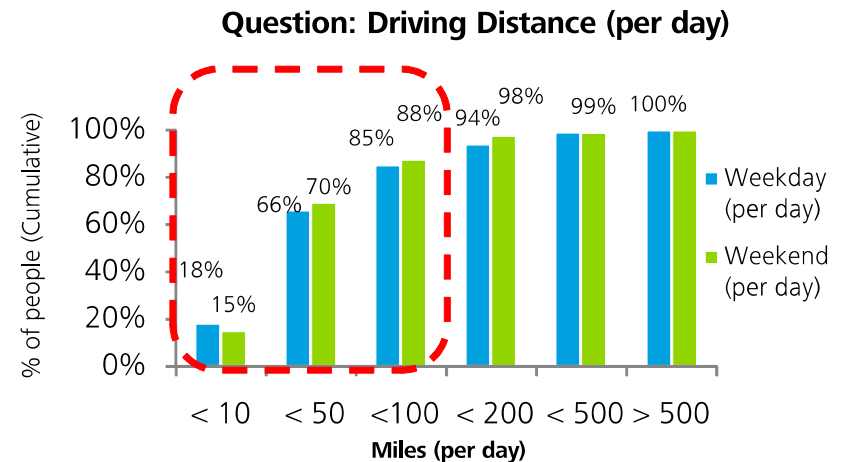


Source: DTTL Global Manufacturing Industry group. Global electric vehicle survey, 2011.

Given the current recharge typically takes eight hours, charge time expectations may also be an issue.

Market Barriers: Range

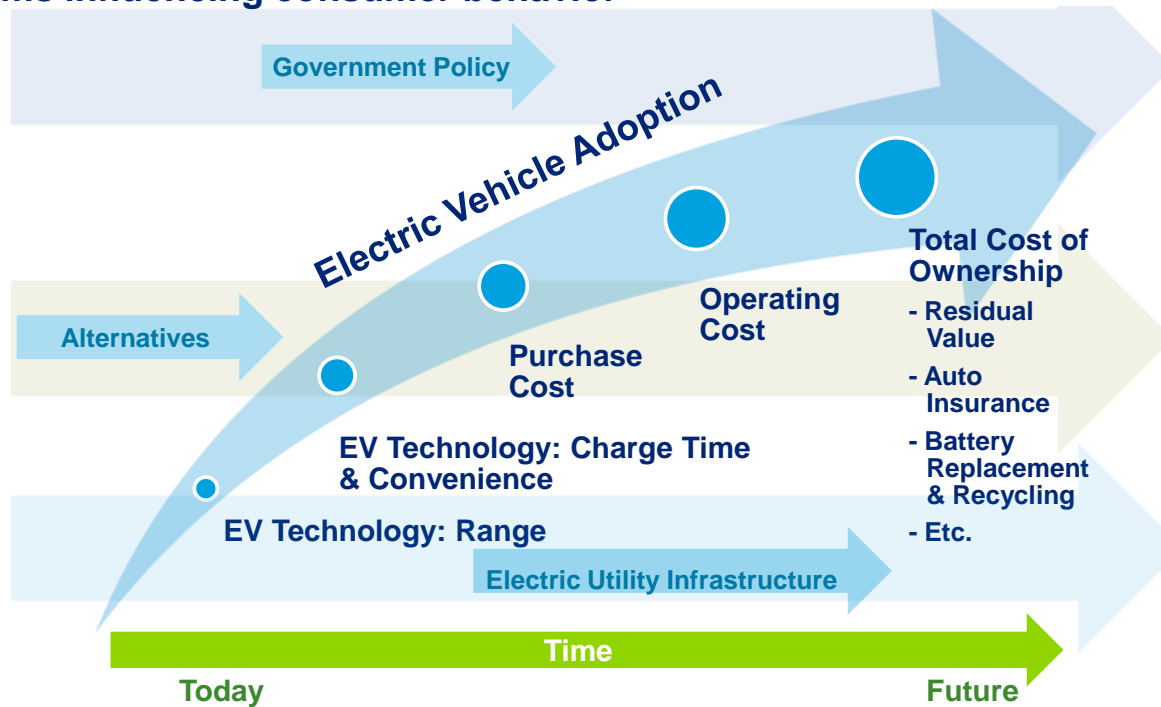
- Range anxiety is a widely noted market barrier to EV penetration.
- This is despite driving distances of < 50 miles per day for a large fraction of drivers (see graphic below).
- One survey found that 70% of drivers surveyed would expect an EV to travel 300 miles before they would consider purchasing one (Deloitte, *Gaining Traction*).
- Current EVs are significantly below this expectation
 - Nissan Leaf: 100 miles (electric)
 - Ford Focus: 100 miles (electric)
 - Tesla Model S: 160 miles (electric)
 - Chevy Volt: 40 miles (electric) + 300 miles (combustion)
 - Fisker Karma: 50 miles (electric) + 300 miles (combustion)



Government Policy

**Sustained policy
support and technology
innovation both critical**

Items influencing consumer behavior



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Gaining traction:
Will consumers ride the electric vehicle wave?

Electric vehicle consumer survey results for China, U.S., Europe and Japan



April 2011

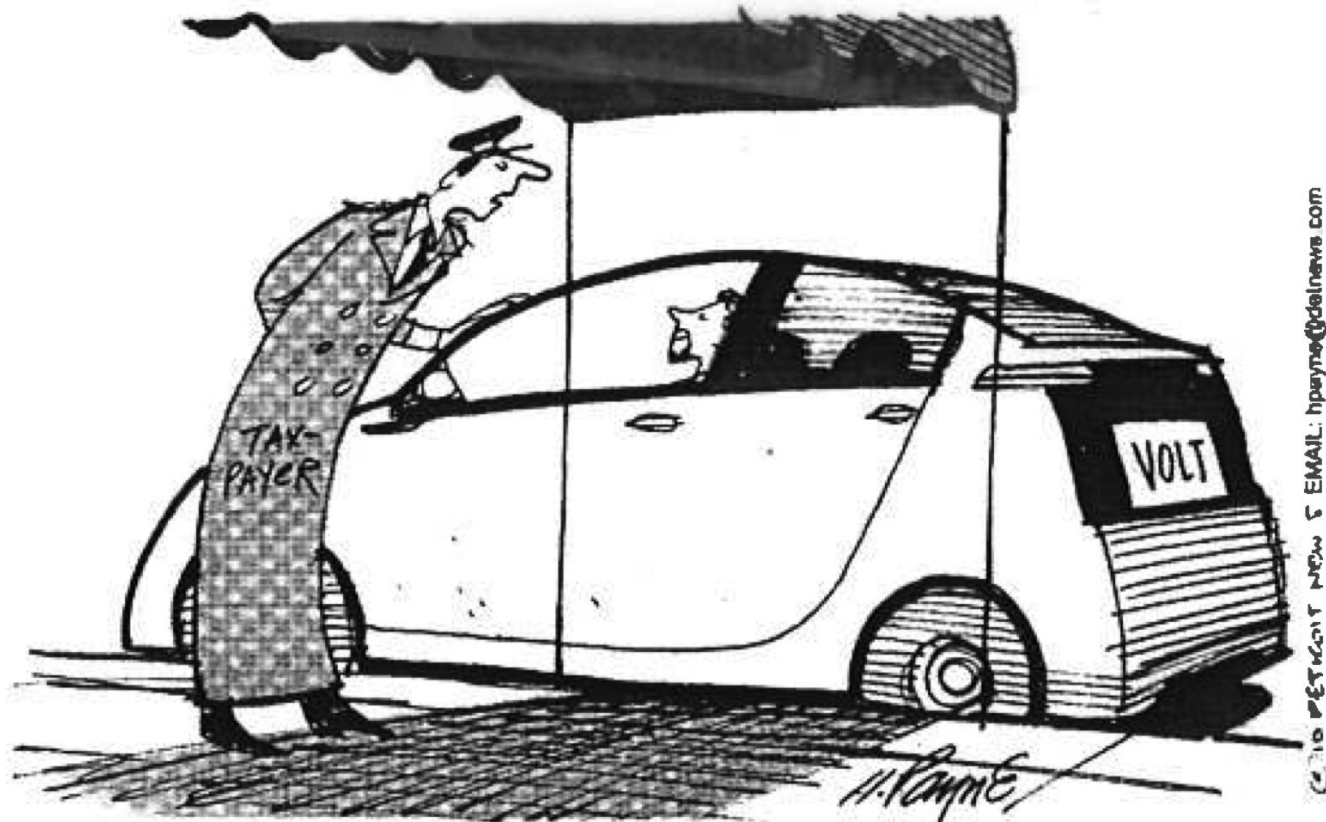
Source: DTTL Global Manufacturing Industry group, Global electric vehicle survey, 2011.

15 Gaining traction: Will consumers ride the electric vehicle wave?

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- Around the world a significant percentage of consumers are identified as either potential first movers or might be willing to consider an EV consumers: ranging from a combined low of 48% in Japan to as high as 93% in China.
- But, when consumers responses regarding their current expectations for EV range, charge time, purchase price and other considerations are screened against today's EV market offerings, the actual percentage of consumers whose expectations will be met today drop to less than 4% in most major automobile markets around the world.
- Over the coming decade, government policies as much or more than EV technology will determine consumer adoption rates.

A serious question: How to target EV subsidies to optimize effectiveness?



*"A \$7,500 tax credit and a free \$5,000 charging station.
Anything else I can get you, Mr. DiCaprio?"*

References

Drive Green 2020: More Hope than Reality?, J.D. Power, November 2010.

Major report takes historical hybrid sales and predicted level of 5% in 2020 as a starting point for assessing likely forecast for battery electrics. Battery electrics forecast at 1.8% global sales in 2020.

The Slow Road to Going Green, J.D. Power and Associates White Paper, August 2011.

Short paper compares hybrids directly with EVs to illustrate the added challenges faced by battery electrics. Predicts BEVs at only 1% of new vehicle sales in the US in 2020. Created a colored map of the US by consumer interest in EVs.

The Comeback of the Electric Car?, Boston Consulting Group, 2009.

Sales forecast from 2008 – 2020 based on BCG's market model in four major auto markets: Western Europe, North America, Japan and China. Under "steady pace" scenario, EVs account for 3% global sales in 2020, and another 3% for PHEVs.

Electric Vehicle Consumer Survey, Pike Research, Q4 2012

Web-based survey of 1,000 customers conducted on annual basis to track trends in consumer attitude. Found decline in interest from 2011 to 2012. Not much difference in consumer attitude towards EVs except younger and higher levels of education. More than 1/3 did not believe that EVs are much cheaper to drive than ICEs.

Gaining Traction: A customer view of electric vehicle mass adoption in the U.S. automotive market, Deloitte, 2010.

Primary research includes interviews with executives from auto companies, start-ups, dealers, energy companies and survey of 2,000 current vehicle owners. Quantified an "early majority segment" of the U.S. by matching criteria against U.S. census data as 1.3 million, or 3.1% of US auto sales in 2020.

Gaining Traction: Will consumers ride the electric vehicle wave?, Deloitte, April 2011. [see also *Unplugged: Electric vehicle realities versus consumer expectations*]

Online survey of 12,000 adults in 16 countries from November 2010 to March 2011. Finds significant gap between EV performance and consumer expectations that will limit market size to 2 – 4% under present conditions.